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RESOURCES

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CONTENTS PAGE

ELECTRIC POWER AND POWER EQUIPMENT

CONTENTS (Continued)

NUCLEAR POWER IN THE USSR

Duesseldorf ATOMWIRTSCHAFT-ATOMTECHNIK in German Aug-Sep 79 pp 417-424

/Article by Devana Lavrencic, Rome/

/Text/ Part II

Abstract: In the future energy supply of the Soviet Union and of the other CEMA countries, nuclear energy will occupy a key role, which is now clearly apparent in the plans. In order to categorize this development, Part I of this paper (in atw 7/79) considered the regional and global allocation of electric supply among individual energy media, and the role of nuclear energy in the energy supply. The following Part II will treat the various types of reactors and the technical-economic indices of the USSR nuclear power plants. All types of reactors exhibit stepwise power increases, using standardized power channels or loops. Fast breeder reactors are purposefully being developed into large units with modern steam parameters. 1500 MW blocks are planned, and 3200/3600 MW blocks are being considered for the year 2000.

3. Water-Water Power Reactors (WWER) (Pressurized Water Reactors)

The first WWER-210[1)] was deployed in the first block of the Novo-Voronesh Nuclear Power Plant KKNV. It had three condensation turbines AK-70-11[2)]. It was started in 1964. In 1969, a second block with a WWER of higher power (WWER-365), together with five condensation turbines K-75-30 was started in the KKNV. In each of the years 1971 and 1972, a series reactor of average power, WWER-440, with two condensation turbines K-220-44, was started up. In 1978, the first high power series reactor (WWER-1000) is supposed to go into operation in the KKNV. The technical

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1) The figure after the abbreviation specifies the gross electric power (in MW).

2) K - condensation turbine; the first figure after the abbreviation specifies the power (MW), the second figure specifies the live steam pressure (kg/cm^2).

design data of the reactors deployed in the KKNV are shown in Table 23. The performance and operating data as well as the electrical power generating costs of the KKNV and of the Kola Nuclear Power Plant (KKKo) are assembled in Table 24.

In nearly all areas of the European part of the Soviet Union, the electrical power generating costs of the KKNV-WWER-440 have proven competitive with the electrical power generating costs of fossil-fuel steam power plants. In 1976, the generation costs of electrical power generated in the KKNV were 0.632 kop/kWh, with a use factor of 76.3%. The generation cost of power delivered from the large-scale steam power plant Krivoy Rog-2 (3000 MW; coal) in the Ukraine was 0.895 kop/kWh. The costs at Konakovo (2400 MW; petroleum, natural gas) was 0.712 kop/kWh. The successful operation of the WWER-440 of the KKNV recommended deployment of these reactors also in other nuclear power plants of the USSR and especially other CEMA countries. At this time, two WWER-440's are in operation in the USSR, besides the WWER-440's of the KKNV. Two others are under construction in the Kola Nuclear Power Plant (KKKo), one WWER-440 is operational in the Armenian Nuclear Power Plant (KKAr), and one is under construction. Two other WWER-440's are anticipated for the Rovno (KKRo) Nuclear Power Plant. These WWER-440's are being built and put in operation as the last ones of this type in the USSR. In the current five-year plan, the construction of medium power WWER's (WWER-440) is therefore terminated, and the transition to the erection of high power WWER's (WWER-1000) is being begun. The series reactors WWER-1000 are intended for deployment in the Kalinin Nuclear Power Plants (KKKa) as well as in southern and western Ukraine (KKSU, KKWU), in the 1980's.

Outside the USSR, however, the WWER-440's continue to be erected with technical assistance from the Soviet Union. The construction of nuclear power plants in other socialist countries in Europe and in Cuba is based on the WWER-440 type.

Within the framework of the complex program of the standing commission of the CEMA for the peaceful utilization of nuclear energy, a total nuclear power plant output of about 37,000 MWe is anticipated in these countries by 1990. This corresponds to an annual saving of about 75 million tons SKE (anthracite units) of primary fossil energy media. At the 32d Session of the CEMA in Bucharest in June 1978, this forecast was confirmed. It was also reported that other CEMA countries will also participate in the erection of two more nuclear power plants in the USSR. Table 25 lists the nuclear power plants, equipped with WWER, operating, under construction, or planned within and without the Soviet Union. As the power of the WWER's is being raised, developments are also being pursued on steam generators and turbo sets, as well as on efficiency improvements of the system. The radioactivity of the primary loop water imposes severe requirements on the manufacture of steam generators. The steam generators of the WWER-440 and WWER-1000 (Table 26) follow the same constructive principles.

Table 23: Main characteristics of pressurized water reactors of the KK Novo-Voronesh

	WWER-210	WWER-365	WWER-440 (1*)	WWER-440 (2*)	WWER-1000
Inbetriebnahme (1)	1964	1969	1971	1972	1978
Bauzeit, Jahre (2)	7,5	5,5	4	4	5
Thermische Reaktorleistung, MW (3)	700	1 320	1 375/1 470		3 000
Elektrische Bruttoreaktorleistung, MW (4)	3·70	5·73	2·220		2·500
Elektrische Nettoleistung (5)			402		
Bruttowirkungsgrad, % (6)	27,6	27,7	31,5	31,8	33
Elektrischer Eigenbedarf, % (7)	8	7,3	6,8		5,3
Sattdampfdruck vor der Turbine, kg/cm² (8)	29	29	43,2		60
Primärkreislaufdruck, kg/cm² (Kühlmitteldruck) (9)	100	105	125		160
Reaktorkühlsystem (Primärkreislauf) (10) (31)	6 Schleife	8 Schleife	6 Schleife		4 Schleife
Speisewassermenge, m³/h (11)	36 500	49 500	39 000		76 000
Druckgefäß (12)					
max. Durchmesser, mm	4 400	4 400	4 350		4 300
Innendurchmesser, mm	3 560	3 560	3 560		4 070
Höhe, mm	11 100	12 000	11 800		10 850
Gewicht, t	185,4	209,2	200,8		304
Dampffördermenge je Dampferzeuger, t/h (13)	230	325	425		1 469
Uranbeschickung, t (14)	38	40	42		66
Brennelemente, Anzahl (15)	312	276	276		151
Brennstäbe je Element (16)	90	126	126		317
Brennstoffanreicherung, % U-235 (17)	2,8	3	3,3		4,4
Mittl. Abbrand des Brennstoffs im stationären Betrieb, MWd/kg U (Soll/Ist) (18)	13/16,7	27,7/28,1	28,6/29,3		26–40
Mittl. Leistungsdichte des Kerns, kW/l (19)	46	80	83		111
Mittl. Brennstoffbelastung, kW/kg U (20)	10,5	33	33		45,5
Regelstäbe, Anzahl (21)	37	73	73		109
Spez. Flußmenge des Kühlmittels, (t/h)/MW (22)	38	30	25		19
Wassertemperatur am Reaktoreintritt, °C (23)	252	252	269		289
Mittl. Aufwärmung des Wassers im Kern, °C (24)	19,1	25,8	31		33,5
Kumulierte Stromerzeugung seit Inbetriebnahme bis 31. 12. 1974, 10^9 kWh (TWh) (25)	10,550	11,159	6,956	5,368	
Spez. Investitionskosten, Rub/kW (26)	406	273	200		
Stromerzeugungskosten, Kop/kWh (Plan) (27)	0,95	0,743	0,643		
Stromerzeugungskosten 1976, Kop/kW (28)	0,786	0,569	0,584		
Eigenstromverbrauch % (Soll/Ist) (29)	8,0/7,91	7,3/5,95	7,15/7,38		
Turbine, Anzahl, Typ (30)	3 AK-70-29	5 K-75-30	2 K-220-44	2 K-220-44	2 K-500-60/1500

1. Start-up; 2. Construction time, years; 3. Thermal reactor power MW; 4. Gross electric reactor power MW; 5. Net electric power; 6. Gross efficiency, percent; 7. Internal electrical demand, percent; 8. Saturated steam pressure before the turbine, kg/cm²; 9. Primary loop pressure, kg/cm² (coolant pressure); 10. Reactor cooling system (primary loop); 11. Amount of feed water, m³/h; 12. Pressure vessel: max. diameter, mm; interior diameter, mm; height, mm; weight, t; 13. Steam quantity conveyed per steam generator, t/h; 14. Uranium charge, t; 15. Fuel elements, number; 16. Fuel rods per element; 17. Fuel enrichment, percent U-235; 18. Average burn-off of the fuel in stationary operation, MWd/kg U(theoretical/actual); 19. Average power density in the core, kW/l; 20. Average fuel charge, kW/kg U; 21. Control rods, number; 22. Specific flow of coolant (t/h)/MW; 23. Water temperature at the reactor intake, degrees C; 24. Average heating of the water in the core, degrees C; 25. Cumulative electrical power generation since start-up up to 31 December 1974, 10^9 kWh (TWh); 26. Specific investment costs, Rub/kW; 27. Power generation costs, Kop/kWh (Plan); 28. Power generation costs 1976, Kop/kW; 29. Internal power consumption percent (theoretical/actual); 30. Turbine, number, type; 31. Loops

Table 24: Operating data for nuclear power plants with WWER

	1969	1970	1971	1972	1973	1974	1975	1976
1. Kernkraftwerk Nowo-Woronesch								
Installierte Leistung, MWe (a)	210	575	1 015	1 455	1 455	1 455	1 455	1 455
Stromerzeugung, GWh (b)	1 437	1 578	2 027,0	5 413,4	8 674,7	9 664,1	9 138,1	9 750,8
Stromabgabe an EEVS, GWh (c)				4 948,7	7 958,7	8 927,5	8 427,0	8 999,7
Eigenbedarf, % (d)	8,53	10,32	7,92	8,58	8,14	7,62	7,78	7,70
Ausnutzungsfaktor, % (e)	79,0	49,0	62,0	60,7	68,0	76,0	71,7	76,3
Bruttowirkungsgrad, % (f)	27,0	26,9	27,23	26,84	27,89	28,27	28,37	28,48
Spezifischer Wärmeverbrauch (netto), kcal/kWh (g)				3 505	3 357	3 293	3 288	3 271
Stromerzeugungskosten, Kop/kWh (h)	0,94	0,967	0,948	0,810	0,752	0,644	0,641	0,632
2. Kernkraftwerk Kola								
Installierte Leistung, MWe (i)					440	880	880	880
Stromerzeugung, GWh (j)					1 021,2	2 218,9	2 642,8	4 775,0
Ausnutzungsfaktor, % (k)					52,5	28,7	34,2	61,1
Stromerzeugungskosten, Kop/kWh (l)					1,996	1,159	1,090	0,780

1. Novo-Voronesh Nuclear Power Plant;
a. Installed power, MWe
b. Electrical power generation GWh
c. Electrical power output to the EEVS, GWh
d. Internal demand, percent
e. Use factor, percent;
f. Gross efficiency percent
g. Specific heat consumption (net), kcal/kWh
h. Electrical power generating cost, Kop/kWh

2. Kola Power Plant
i. Installed power, MWe
j. Electrical power generation GWh
k. Use factor, percent
l. Electrical power generating costs, Kop/kWh

Table 25: Nuclear Power Plants with WWER inside and outside the USSR

(1) Kernkraftwerk		(2) Staat	(3)	Elektr. Leistung Brutto MW	(4) Netto	(5) Baubeginn	(6) 1. Kritikalität	(7) Inbetriebnahme
Nowo Woronesch-1	(8)	UdSSR	(31)	210	196	3. 1957	10 1963	12 1964
-2		UdSSR		365	336	1965	12 1969	4 1970
-3		UdSSR		440	410	1968	12 1971	6 1972
-4		UdSSR		440	410	1968	12 1972	4 1973
Kola-1	(9)	UdSSR		410	370			1973
-2		UdSSR		410	370			12 1974
Armenien-1	(10)	UdSSR			400			12 1976
Rheinsberg	(11)	DDR	(32)	70	62.5	1960	3 1966	10 1966
Bruno Leuschner-1	(12)	DDR		440	408	10. 1969	12 1973	7 1974
-2		DDR		440	408	1970	12 1974	12 1974
Kosloduy-1	(13)	Bulg	(33)	440	432	4. 1970	6 1974	7 1974
-2		Bulg		440	405	4. 1970	8 1975	11 1975
Armenien-2	(14)	UdSSR	(34)		400			1979
Nowo Woronesch-5	(15)	UdSSR			1000	1973	1978	1979
Rowno-1	(16)	UdSSR		440	420			1980
-2		UdSSR		440	420			1980
Kola-3	(17)	UdSSR		440	420			1980
-4		UdSSR		440	420			1980
Bruno Leuschner-3	(18)	DDR	(35)	440	408			1978
-4		DDR		440	408			1980
Magdeburg-1	(19)	DDR		440	408			
-2		DDR		440	408			
-3		DDR		440	408			
-4		DDR		440	408			
Kosloduy-3	(13)	Bulg	(36)	440	432	1972		1978
-4		Bulg		440	432	1972		1979
Loviisa-1	(20)	Finnl	(37)	440	420	6 1971	1977	5 1977
-2		Finnl		440	420	8 1972	8 1979	11 1979
Jasl. Bohunice-1	(21)	ČSSR	(38)	413	380	4 1974		1978
-2		ČSSR		413	380	4. 1974		1979
Dukovany-1	(22)	ČSSR		440	420			1980
-2		ČSSR		440	420			1981
Jasl. Bohunice-3	(23)	ČSSR		440				1982
-4		ČSSR		440				1983
Dukovany-3	(24)	ČSSR		440				1983
-4		ČSSR		440				1984
Paks-1	(25)	Ung	(39)	440	408	1973		1980
-2		Ung		440	408	1975		1982
Zarnowiec-1	(26)	Polen	(40)	440				1984
Zienfuegos-1	(27)	Kuba	(41)	440				1984
Kalinin-1, 2, 3, 4	(28)	UdSSR	(42)	1000				1990
Nikolaev-1, 2, 3, 4	(29)	UdSSR		1000				1990
Westukraine-1, 2, 3, 4	(30)	UdSSR		1000				1990

1. Nuclear power plant; 2. Country; 3. Gross electric power MW; 4. Net; 5. Beginning of construction; 6. First criticality; 7. Start-up; 8. Novo Voronesh; 9. Kola; 10. Armenian; 11. Rheinsberg; 12. Bruno Leuschner; 13. Kosloduy; 14. Armenian; 15. Novo-Voronesh; 16. Rovno; 17. Kola; 18; Bruno Leuschner; 19. Magdeburg; 20. Loviisa; 21. Jasl. Bohunice; 22. Dukovany; 23. Jasl. Bohunice; 24. Dukovany; 25. Paks; 26. Zarnoviec; 27. Cienfuegos; 28. Kalinin; 29. Nikolaev; 30. West Ukraine;31. USSR; 32. GDR; 33. Bulgaria; 34. USSR; 35. GDR; 36. Bulgaria; 37. Finland; 38. CSSR; 39. Hungary; 40. Poland; 41. Cuba; 42. USSR

Table 26: Steam generator for WWER-440 and WWER-1000 Systems

	WWER-440	WWER-1000
Thermal power, 10 Gcal/h	195	645
Steam generation, t/h throughput	452	1,470
Primary loop pressure, kg/cm^2	125	160
Primary loop temperature, entry/exit, ^{o}C	301/268	322/289
Steam condition, pressure kg/cm^2/temperature ^{o}C	47/260	64/278.5
Heating surface, m^2	2,510	6,115
Number of tubes	5,536	16,920
Tube dimensions, diameter wall thickness, mm	16·1.4	16·1.5
Weight, t	156	240
Dimensions: Diameter·Length, m	3.2·12	4.0·13.5

The experience gained in the construction and operation of the WWER's can also be used for applying these reactors to remote heat supply. The first step in this direction is the deployment of reactors, which are already used in nuclear power plants, in nuclear heating plants (KHKW). Changes are then necessary only in the turbine part of the system, taking special account of the radiation protection and safety of such systems, which are to be erected close to densely settled areas.

Boiling water reactors in prestressed concrete pressure vessels have several advantages for deployment in KHKW. An optimized system can be planned, as regards its principal characteristics and operating parameters, on the basis of the design, construction, and operation of three generations of WWER's and of the WK-50 boiling water reactor. Special reactors for nuclear heating purposes will be provided for WWER's which are to be used in the area of heat supply. The simplification here consists of the natural circulation of the coolant, integral construction of the equipment, and automation of the system.

In such a three-loop system, the steam pressure in the primary loop does not exceed 12-16 kg/cm^2, which results in a simplification of the equipment.

Besides the simplification of the equipment, heat generation in the low temperature range (150-170^{o}C) permits costs to be reduced and the operating safety of the system to be increased. In any case, however, more stringent requirements must be imposed on reactor safety and radiation protection when the nuclear reactors are used to generate heat in KHW and KHKW. The KHKW is supposed to become economical at a reactor power of 500 MW.

4. LWGR (Light Water Cooled Reactors) Channel Reactors

Besides the pressurized water reactors WWER, a second type of thermal reactor was developed in the Soviet Union for deployment in nuclear power plants. This was the pressure tube reactor (with slightly enriched uranium, graphite-moderated, water-cooled). The foundation for this is the AM-1 reactor of the first nuclear power plant in the world (KKOb). The technical design data of the various pressure tube reactors in operation, under construction, and being planned, are assembled in Table 27. This reactor design and its operating safety have been confirmed by a number of factors: operation of the AMB-1 and AMB-2 of the Byeloyarsk (KKBye) with nuclear superheating, turbine operation (VK-100-6) with slightly radioactive steam, good operating characteristics of the fuel elements at supercritical steam parameters (500-540^{o}C) and high thermal fluxes (up to $1 \cdot 10^6$ kcal/m$^3 \cdot$h), as well as the burn-off achieved (30 MWd/kg).

In one group of superheated channels of the AMB-2, the burn-off has recently been increased to 1200-1300 MWd/working channel (37-40 MWd/kg), in order to bring the maximum steam exit temperature from both channels to 560-565^{o}C. Furthermore, a heating steam extraction system (~20Gcal/h) has actually been developed into a remote heat supply with the AMB-2.

Furthermore, in the KKBs, the heat is coupled out through an intermediate heating loop, in order to prevent the heat medium from being activated. The technical safety questions involved in transferring the heat to the heating water essentially correspond to those of the feed-water preheating loop with the KKW.

The turbine steam is tapped with six steam-water preheaters, two on each of the three VK-100-6 turbines. In the preheaters, the water is heated in two stages, with steam from uncontrolled taps. The maximum heat coupled out is 21 Gcal/h (24.4 kW) or 7 Gcal/h (8.1 kW) per turbine.

In the years 1973 through 1976, four pressure tube reactors without steam superheating (EPG-6) were started in the extreme northern portion of the USSR, on the Chukch peninsula. Each of these had 12 MWe to generate electrical power and remote heat (25 Gcal/h each). (KHKBi). These reactors are characterized by natural circulation of coolant. The system is provided with HK-turbines, of the Skoda type (CSSR) and with Heller dry cooling towers (Hungary).

The power generating costs of the AMB-2 (0.92-0.93 kop/kWh) are comparable with the power generating costs of conventional heat power plants deployed in the Ural. The power generating costs of the KHKBi (5 kop/kWh) are lower than the power generating costs of the diesel power plants (7-20 kop/kWh), which are deployed in the same area.

Table 27: Main characteristics of the U-graphite-H_2O channel reactors

Kernkraftwerke mit Kanalreaktoren (1)	KK Obninsk	KK Bjelojarsk		KHK Bilibino (4 Reaktoren) (2)	KK Leningrad KK Kursk KK Tschernobyl	KK Ignalina (in Bau) (3)	Projekt (4)
Reaktortyp (5)	AM-1	AMB-1	AMB-2	EPG-6	RBMK-1000	RBMK-1500	RBMKP-2400
Elektrische Leistung, MW (6)	5	100	200	12(+25 Gcal/h)	1000	1500	2400
Thermische Leistung, MW (7)	30	285	530	62	3200	4800	6500
Dampferzeugung, t/h (8)				96 (65 kg/cm²)	5800	8800	9600
Dampfzustand vor der Turbine (9)							
Druck, kg/cm² (10)	12,5	90	78	65	65	65	65
Temperatur, °C (11)	270	512	520	280	280	280	450
Kernabmessungen, mm (12)							
Durchmesser (Ø) oder Länge (13)	Ø1500	Ø7200	Ø7200	Ø4200	Ø11800	Ø11800	7500 2700
Höhe (14)	1700	6000	6000		70	7000	7000
Leistungskanäle (15)							
Verdampferkanäle (16)	128	730	730	273	1693	1661	1920
Überhitzerkanäle (17)	—	268	268	—	—	—	960
Uranbeschickung, t (18)	0,55	90		7,2	192	189	293
Brennstäbe je Kanal (19)	4	6	6		18		
Brennstababmessungen, mm (20)							
Durchmesser (21)	Ø 9,4	Ø 9,4	Ø 10,2		Ø 13,5	Ø 13,5	
Hüllmaterialdicke (22)		0,6	0,6		0,9	0,9	
Urananreicherung, % U-235 (23)	5	1,8	3,0	3,0 und 3,3	1,8	1,8	1,8/2,3
Mittl. Abbrand des entladenen Urans, MWd/kg U (24)		4,0	14,6	20,0			
Verdampferkanäle (25)					18,1	18,1	19,4
Überhitzerkanäle (26)					—	—	18,1
Regelstäbe, Anzahl (27)	20	100	100	60			
Kühlmitteldruck am Reaktoreintritt, kg/cm² (28)	100	155	110				
Kühlmitteltemperatur am Reaktoraustritt, °C (29)							
Verdampferkanäle (30)		340	345				
Überhitzerkanäle (31)		512	520	284	284	284	
Dampfgehalt am Austritt (Gew.-%) (32)		15,3	21,7	16,7	15	15	
Max. Graphit-Temperatur, °C (33)		725	735	700			
Max. Brennstabtemperatur, °C (34)				350			
Abscheiderdruck, kg/cm² (35)				65	70	70	
Reaktorwasserdurchsatz, t/h (36)		2400	3400	540	37500	29000	
Turbinen, Anzahl, Leistung, MW (37)	1 6	1 100	2 100	4,12	2 500	2750	2 1200
Inbetriebnahme des ersten Blocks (38)	1954	1964	1967	1973	1973	nach 1980 (39)	

Betriebsdaten (40)		KKBje	KHKBi	KKLe[1]
Stromerzeugung, GWh (41)	1974	1 703,3	61,85	4 053
	1975	2 025,4	143,20	6 250
	1976	1 120,8	207,20	10 000
Stromerzeugungskosten, Kop/kWh (42)	1974	1,116	17,05	
	1975	1,09	10,90	
	1976	1,10	9,80	
Ausnutzungsfaktor, % (43)	1974	65,0	59,0	
	1975	77,0	68,1	
	1976		68,0	

[1] Das KKW Leningrad hat in den Jahren 1974 bis 1978 45 TWh erzeugt. (44)

1.Nuclear power plants with channel reactors; 2.(4 reactors); 3.(under construction); 4.Project; 5.Reactor type; 6.Electrical power MW; 7.Thermal power MW; 8.Steam generation t/h; 9.Steam condition before the turbine; 10.Pressure kg/cm^2; 11.Temperature^{o}C; 12.Core dimensions mm; 13. Diameter (Ø) or length; 14.Height; 15.Power channels; 16.Evaporator channels; 17.Superheater channels; 18.Uranium charge, t; 19.Fuel rods per channel; 20.Fuel rod dimensions mm; 21.Diameter; 22.Thickness of cladding material; 23.Uranium enrichment % U-235; 24.Average burn-off of the discharged uranium, MWd/kg U; 25.Evaporator channels; 26.Superheater channels; 27.Control rods, number; 28.Coolant pressure at the reactor entry kg/cm^2; 29.Coolant pressure at the reactor exit ^{o}C; 30.Evaporator channels; 31.Superheater channels; 32.Steam content at the exit (weight %); 33.Maximum graphite temperature ^{o}C; 34.Maximum fuel rod temperature ^{o}C; 35.Separation pressure kg/cm^2; 36.Reactor water throughput t/h; 37.Turbines, number, power, MW; 38.Start-up of the first block; 39.after; 40.Operating data; 41.Generation of electric power GWh; 42.Electric power generation costs Kop/kWh; 43.Use factor %; 44. [1]The Leningrad KKW generated 45 TWh during the years 1974 through 1978.

The RBMK-1000 series reactor (1000 MWe high-power channel reactor) without nuclear superheating represents the advanced development of the LWGR channel reactors. In this reactor, a zirconium alloy, instead of special steel, is used as cladding and pressure tube material.

The first one of these reactors was put in operation in 1973, in the Leningrad Nuclear Power Plant (KKLe). Subsequently, the RBMK-1000 of the second block of the KKLe (1974), the two blocks of the Kursk Nuclear Power Plant (KKKu 1976/78), and of the Chernobyl Nuclear Power Plant (KKTch 1977/78) began operating.

At this time, two more blocks with RBMK-1000 are under construction in the KKLe, KKKu, KKTch, and in the Smolensk Nuclear Power Plant (KKSm).

Operation of the RBMK-1000 indicated that the parameters which determine the specific power density do not represent an upper limit. The main coolant pumps also had enough reserve to increase the pressure. This affords an opportunity for increasing the power of the reactor. Out-of-pile experiments have shown that the channel power can be increased by 50% by increasing the heat exchange. A project study of the RBMK-1500 was made in 1975. This study indicated that the power of the RBMK-1000 can be brought to 1500 MWe without changing the structure of the reactor. It is only necessary to install grids in the power channels, to produce an axial torsion of the coolant flow and consequently better heat exchange. The first and second block of the Ignaline Nuclear Power Plant (KKIg) are being equipped with the RBMK-1500. This power plant is constructed in Lithuania. The next step in the development of channel reactors is designing an RBMK reactor with 2000-2400 MWe power and nuclear superheating, by using zirconium alloys as the structural material.

The power channels are independent of one another and are mass-produced. They make it possible to increase the power of the channel reactor still more. The supercritical parameters of superheated steam furthermore make it possible to use modern turbines, built for conventional power plants. They also facilitate uninterrupted charging with fuel by replacing the power channels during reactor operation. They also allow an increased rate of load change of the nuclear power plant.

5. Fast Breeder Reactors

The prevailing conviction is that only fast breeders can secure a long-term economic nuclear fuel supply with optimum fuel utilization. Present development work consequently concentrates on fast sodium-cooled breeder reactors. Experience was gained in the construction, conversion, and operation of the BR-5 reactor, as well as in the construction and operation of the fast BOR-60 experimental reactor. On this basis, the BN-350 prototype nuclear power plant was constructed and put in operation. The

demonstration breeder power plant BN-600 is still under construction. The purpose of these prototype and demonstration systems is to try out the main components and equipment for commercial fast breeder power plants, the utilization of the sodium coolant on a large technical scale, and the search for an optimum design solution (loop or pool).

At this time, a prototype is being developed for series-production fast sodium-cooled breeder reactors with high power, BN-1600, taking into account the experience with the BN-350 and the BN-600, but with higher technical and economic parameters. The principal equipment for this reactor is also being developed.

The main characteristics of the BN-1600, together with the characteristics of fast experimental and demonstration breeders developed in the Soviet Union, are assembled in Table 28.

The fast experimental reactor BOR-60 was built in the Research Institute for Nuclear Reactors in Dimitrovgrad. It was based on the design data for large, industrial fast breeder systems. It has been operated in Dimitrovgrad since 1969. Its three-loop circuit permits parallel heat dissipation through air-heat exchangers and through steam generators with a turbo set for generating electrical power.

Since it was started up (19 December 1969) up until 1 January 1978, the BOR-60 has delivered a total of 200 GWh electric power to the network, as well as 1450 GWh heat. Equipment is being tried out for industrial fast breeder systems. At this time, fuel elements with various designs, fuel, and fabrication are in particular being tried out under operating conditions approaching those of fast, sodium-cooled power reactors. Studies are being performed on models of various steam generators.

The BN-350 fast breeder power plant is located at the east shore of the Caspian Sea, in an area that is rich in petroleum but poor in fresh water, far from industrial centers. The nuclear power plant delivers electrical power and remote heat for the 120,000 inhabitants of the city of Chevtchenko. It also provides process heat for a seawater desalination system. The desalinated water secures the water supply of the populace and of industry, and also makes it possible to provide the city with green areas and parks in a desert area. The data on the operation of the BN-350 are assembled in Table 29. Since March 1976, the reactor has been operating at 65% rated power (650 MWth) with five out of six loops of the primary circulation. It provides 120 MWe electric power as well as 50,000 m^3/day desalinated water. No unplanned shutdown occurred in 1976.

The BN-600 was designed with higher parameters than the BN-350: sodium temperature, steam parameters, thermal power, burn-off, longer operating time between recharging of fuel elements. In order to make the system

Table 28: Main characteristic of fast breeder reactors

Na-Brüter (1)	BR-10[1])	BOR-60	BN-350 „loop"	BN-600 „pool"	BN-1600 „pool"
Standort (2)	Obninsk	Dimitrowgrad	Schewtschenko	Bjelojarsk	
Inbetriebnahme (3)	1973	1969	1973	1979	Projekt
Thermische Leistung, MW (4)	8,5–7,5	60	1 000	1 470	4 200
Elektrische Leistung, MW (5)	—	12	150[2])	600	1 600
Bruttowirkungsgrad, % (6)		20	35	41	40
Reaktorbehälterabmessungen Durchmesser/Höhe m/m (7)		1,5/1,1	6/13	12,9/13	18,3/18
Kernabmessungen: Durchmesser/Höhe cm/cm (8)	28/32	41/40	150/106	205/75	335/100
Ladung, kg U-235/Anreicherung % (9)		150/90	1050/23	1260/	
Konversionsfaktor („equilibrium" Pu-Ladung) (10)			1,5	1,4	1,4
Maximaler Neutronenfluß, n/cm² sec (11)	$1,5 \cdot 10^{15}$	$3,3 \cdot 10^{15}$	$0,8 \cdot 10^{16}$	$1 \cdot 10^{16}$	$1 \cdot 10^{16}$
Maximaler Abbrand, Atom-% (12)	7	10	5,7	10	10
Maximale Leistungsdichte, kW/l (13)	780	1 180	730	840	710
Betriebszeit zwischen Umladungen, Monate (14)			2	5	4–6
Primärkreislauf: (15)					
Anzahl der Schleifen (16)		2	5	3	4
Na-Durchsatz, t/h (17)		~ 1 000	14 000	24 000	60 000
Na-Temperatur, Reaktor-Eintritt/Austritt, °C (18)	350/500	360/530	300/500	380/550	350/550
Na-Gewicht, t (19)					2 000
Na-Umwälzpumpen: (20)					
Pumpleistung, m³/h (21)	150	600	3 200	9 400	15 000
Förderhöhe, m (22)	40	85	110	89	95
Sekundärkreislauf (23)					
Na-Durchsatz, t/h (24)	—		5 3200	3 6800	
Na-Temperatur, Wärmeaustauscher-Eintritt/Austritt, °C (25)			270/450	320/520	310/505
Na-Umwälzpumpen (26)					
Pumpleistung, m³/h (27)		830	3 700	8 000	
Förderhöhe, m (28)		60	68	58	
Turbinen, Anzahl Leistung, MW (29)	—	1 12	3 50	3 200	2 800
Dampfzustand vor der Turbine, Druck/Temperatur, kg/cm²/°C (30)	—	3/430	5/435	14/505	14/490–513

[1]) BR-5 nach Umbau: Nennleistung 10 MWth (31)
[2]) Zuzügl. 5000 t/h entsalztes Wasser (32)

1. Sodium breeder; 2. Location; 3. Start-up; 4. Thermal power MW; 5. Electrical power, MW; 6. Gross efficiency %; 7. Reactor vessel dimensions: diameter/height, m/m; 8. Core dimensions: diameter/height, cm/cm; 9. Charge, kg U-235/enrichment %; 10. Conversion factor (equilibrium Pu charge); 11. Maximum neutron flux, n/cm^2 sec; 12. Maximum burn-off, atom %; 13. Maximum power density kW/1; 14. Operating time between recharging, months; 15. Primary loop:; 16. Number of loops; 17. Na throughput t/h; 18. Na temperature, reactor-entry/exit, ^{o}C; 19. Na weight, t; 20. Na rotary pumps:; 21. Pump power m^3/h; 22. Conveyance height, m; 23. Secondary loop:; 24. Na throughput, t/h; 25. Na temperature, heat exchanger-entry/exit, ^{o}C; 26. Na rotary pumps:; 27. Pump power, m^3/h; 28. Conveyance height, m; 29. Turbines, number· power, MW; 30. Steam condition before the turbine, pressure/temperature, kg/cm^2/^{o}C; 31. [1])BR-5 after conversion; rated power 10 MWth; 32. [2])Additional 5000 t/h desalinated water.

Table 29: Operating data for the KHKW Chevchenko

BN-350: rated power 1000 MWth

I. First criticality: 29 November 1972
Start-up experiments
6% rated power (+646 m^3/h desalinated water): 15 March 1973
Leakage at the steam generators (DE)
DE-3, DE-1 (April 1973); DE-2 (May 1973); DE-1 (July 1973).

II. Start-up: 16 July 1973
20% rated power (with three loops in the primary circulation)
(DE-4, 5, 6):
Deployment of one turbo set and connection to EVS Mangychlak.

III. Operating period: July 1973-August 1975
35% rated power (350 MWth):
Investigation of physical and thermal reaction parameters:
Leakage at steam generators (manufacturing defects):
DE-6 (Sept. 1973); DE-5 (October 1973, again in operation January 1975; failure February 1975);
Quality tests and general repair on five out of six existing steam generators;
52%-56% rated power: October 1975.

IV. 65% rated power (650 MWth): 10 March 1976
(with five steam generators; DE-5 eliminated)

Na temperature, reactor-entry/exit °C	280/410
Na temperature, DE-entry/exit °C	255/390
Hot steam throughput, t/h	940-960
Electric power, MW	120-125
Amount of distillate, t/day	50,000-80,000

V. Operating period: 10 March 1976 - 1 January 1978

Cumulative electric power generation, TWh	1.76
Cumulative amount of distillate, t	$4.7 \cdot 10^7$

Table 30: BN-350 and BN-600 with "shell-and-tube" intermediate heat exchangers

Heat Exchanger	BN-350 System	BN-600 System
Type	Horizontal	Vertical
Power, MW	200	245
Primary loop:		
Na throughput, t/h	2,830	4,000
Na temperature, entry/exit, °C	500/300	550/377
Hydraulic loss, kg/cm^2	0.146	0.092
Secondary loop:		
Na throughput, t/h	3,140	3,750
Na temperature, exit/entry, °C	453/273	518/328
Hydraulic loss, kg/cm^2	2.24	0.74
Heat transfer coefficient (tube), W/m^2·°C	5,800	6,650

more reliable and safe, integral expansion of the primary loop ("pool") and a modular steam generator were used (Table 30). The emergency cooling system was also significantly improved. The reactor is scheduled to start up in 1979.

The present development phase is concerned with an optimal solution for the core, the heat transfer system, and the equipment. In the BN-1600 project, the power density of the BN-600 is to be combined with good fuel conversion characteristics. U/Pu mixed oxides are chosen as fuels, so that the first phase of the development of large SBR's will be based on an internationally proven fuel.

The BN-1600 is a three-loop system: The primary and secondary loops each contain four parallel sodium loops. The tertiary loop contains steam and water. The primary loop has integrated construction. An intermediate heat exchanger and a pump are part of each loop of the primary system.

A heat exchanger and a steam generator are part of each of the four loops of the secondary system.

Several reliable technical solutions, that were worked out for the BN-600, were also retained here. The modular steam generator of this system will also be used with the BN-1600, in this development stage. In order to select steam parameters, optimization studies were performed in the ranges from 90 at/450°C to the supercritical values of 220-240 at/530°C. The most important difference between the heat transfer system of the BN-1600 and the BN-600 is the absence of the intermediate sodium loops in the BN-1600. Instead of these, live steam is taken from the feed line of the MD-turbine for secondary superheating. The power plant will be equipped with two conventional 800 MW3 turbo sets, which have already been developed.

6. Equipment of the KKW

Table 31 presents the principal characteristics of reactors and turbo sets installed in Soviet nuclear power plants, as well as the anticipated advance development of the nuclear power plant equipment, keyed by reactor type. During the next 15 to 20 years, the large thermal reactors WWER-1000 and 2000, as well as the RBMK-1500 and 2400 will still play a leading role in the atomic generation of electricity. During the next 5 to 7 years, industrial construction and deployment is expected for the following units: the WWER-1000 and WWER-2000, with 1000 MW and respectively 2000 MW turbo sets, the RBMK-1500 with two 750 MW turbo sets, and the RBMK-2400 with two 1200 MW turbo sets, in base load condensation power plants. Furthermore, the blocks with WWER-1000 and RBMK-1000 will be equipped with heating power turbines (T and PT) for coupling out the heat.

Table 31: Equipment of the nuclear power plants in the Soviet Union

Typ (1)	Bezeichnung (2)	Reaktor (3) Leistung (4) MWth	MWe	Typ (5)	Turbine (7) Leistung MW (6)	Dampfdruck at (8)	Dampftemperatur °C (9)	Generator (11) Leistung MW (10)	Drehzahl U/min (12)
DWR	WWER	760	210	AK	70	29	230	70	1500
	WWER	1320	365	K	75	30	230	75	1500
	WWER	1375	440	K	220	44	258	220	1500
	WWER	3000	1000	K	500	60	274	500	1500
	WWER	3000	1000	K, T_x, PT_x	1000	60	274	1000	1500
	WWER		2000	K	2000	60	315	2000	1500
SWR	WK	150	50	K	50	29	230	50	1500
	WK	1850	500	K, T, PT	500	60	274	500	1500
LWGR	AM-1	30	5	K	6				
	AMB-1	286	100	K	100	90	512	100	1500
	AMB-2	530	200	K	100	78	520	100	1500
	RBMK	3200	1000	K	500	65	280	500	3000
	EPG-6	62	12	T_x	12	60 (74 max.)	289 (max.)	12	1500
	RBMK	4800	1500	K, T_x	750	65	280	800	3000
	RBMK	4800	1500	T_x	500–750	65	280	800	3000
	RBMK	6500	2400	K	1200	65	450	1200	3000
SNR	BOR-60	60	12	K	12	85	430	12	
	BN-350	1000	150	PT_x	50	50	435	50	3000
	BN-600	1470	600	K	200	130	505	200	
	BN-1600	4200	1600	K	800	130	490	800	3000

1. Type
2. Designation
3. Reactor
4. Power
5. Type
6. Power
7. Turbine
8. Steam pressure
9. Steam temperature
10. Power
11. Generator
12. Speed
    rpm

In the near future, the problem of the KHKW will have to be solved, which concerns the size and structure of the connections when using the condensation and extraction-condensation turbines with regulated hot steam (nuclear heating plants with mixed equipment). This is necessary so that the progression effect of reactor unit power can be fully utilized. In some areas, the lack of cooling water precludes the deployment of the above-mentioned large reactors, if the nuclear power plants are to be near their load points. For such cases, the 500 MWe boiling water reactor (WK-500) should be provided with T-, PT-heating turbine. Beyond the KHKW, the construction of nuclear heating plants (400-500 Gcal/h) with special reactors should also be considered.

In the next decade, large sodium-cooled fast breeder reactors will be further developed, SBR (fast breeder reactor) demonstration systems and commercial SBR systems will be constructed, and investigations on gas-cooled fast breeder reactors will be continued. The fast reactors should make it possible to use turbo sets with modern steam data, which were developed for conventional power plants.

A high demand for nuclear energy is forecast for the end of this century. At the present time, developments are already in progress which aim at unit powers of the magnitude of 3200/3600 MWe.

7. Technical-economic Indices of USSR Power Plants

An analysis of the fuel-energy balance for the next 20 years can indicate the most effective strategy for the country's electrical industry. Coal from the Ekibastus, Kansk-Achinsk, and Kuznetsk coal deposits, natural gas from the Tyumen deposits, nuclear fuel, and hydropower from the eastern regions are primarily anticipated to be used to produce electric power. Primary energy media, whose supplies are small or whose economic utilization is possibly only where they occur (oil slate, hydropower in the European part of the USSR, etc.) have little effect on the heat-energy balance of the country. The energy media from Central Asia, the Far East, and Yakut are just as insignificant. These have therefore been neglected in the present analysis. On the other hand the choice of the best fuel-energy base, for areas such as the European part of the USSR (center), the Ural, and Siberia is highly significant for the further expansion of the electrical industry. For power generation in Kazakhstan, only the Ekibastus, Maikyuben, and Turgan coal can be used economically within the next 10 years. According to the USSR Minenergo data, construction of nuclear power plants and coal power plants in the Center, and construction of natural gas power plants in the Ural and in Siberia, as well as the construction of hydropower plants are anticipated within the next decade.

To transmit electricity from Siberia to the Center and to the Ural, 2250 kV DC transmission lines are anticipated. From Ekibastus to the

Table 32: Power plant alternatives in various areas of the Soviet Union

Technisch-wirtschaftliche Indices der Kraftwerke (1)	(2) Wasserkraftwerke in Sibirien	(3) Kernkraftwerke Zentrum (4)	Ural (5)	Sibirien (6)	(7) Wärmekraftwerke (Erdgas) Zentrum (8)	Surgut (9)	Ekibastus (10)	(11) Wärmekraftwerke (Kohle) Kansk-Atschinsk (12)	(13) Kusnetzk Zentrum (14)	Ural (15)
(16) Elektrizitätsversorgung des Zentrums										
Investitionskosten, Rub/kW (19)	498.7	380.0	—	—	328.0	407.0	374.8	374.8	343.5	—
Stromerzeugungskosten, Kop/kWh (20)	0.365	0.687	—	—	0.854	0.753	0.624	0.672	1.075	—
Gesamtkosten¹), Kop/kWh (21)	1.46	1.15	—	—	1.06	1.32	1.22	1.28	1.35	—
(17) Elektrizitätsversorgung des Urals										
Investitionskosten, Rub/kW (22)	468.5	—	391.5	—	—	324.9	287.0	350.3	—	274.5
Stromerzeugungskosten, Kop/kWh (23)	0.331	—	0.709	—	—	0.654	0.520	0.630	—	0.744
Gesamtkosten, Kop/kWh (24)	1.38	—	1.1[illegible]	—	—	1.08	0.96	1.18	—	1.02
(18) Elektrizitätsversorgung Sibiriens										
Investitionskosten, Rub/kW (25)	300.0	—	—	413.0	—	—	278.2	213.8	—	—
Stromerzeugungskosten, Kop/kWh (26)	0.100	—	—	0.740	—	—	0.508	0.443	—	—
Gesamtkosten, Kop/kWh (27)	0.92	—	—	1.26	—	—	0.93	0.74	—	—

¹) Amortisierung + jährliche Betriebskosten (28)

1. Technical-economic indices of the power plants
2. Water power plants in Siberia
3. Nuclear power plants
4. Center
5. Ural
6. Siberia
7. Heat power plants (natural gas)
8. Center
9. Surgut
10. Ekibastus
11. Heat power plants (coal)
12. Kansk-Achinsk
13. Kuznetsk
14. Center
15. Ural
16. Electrical supply for the center
17. Electrical supply for the Ural
18. Electrical supply for Siberia
19. Investment costs, Rub/kW
20. Power generation costs, Kop/kWh
21. Total costs¹), Kop/kWh
22. Investment costs, Rub/kW
23. Power generation costs, Kop/kWh
24. Total costs, Kop/kWh
25. Investment costs, Rub/kW
26. Power generation costs, Kop/kWh
27. Total costs, Kop/kWh
28. ¹)Amortization + annual operating costs

Center, there will be 1500 kV DC transmission lines, and from Ekibastus to the Ural and to Siberia as well as from Surgut to the Ural, there will be 1150 kV AC transmission lines.

The far transmission of electricity, which was obtained from Ekibastus and from Kansk-Achinsk coal, has been accepted, because rail transport of this brown coal, with its low heating value, would not pay, in contrast to the Kuznetsk anthracite coal. Furthermore, transport of the Kansk-Achinsk coal is also connected with technical difficulties.

Table 32 shows the new types of power plants which have been proposed for erection in the above-mentioned areas. Accordingly, nuclear power plants and natural gas heat power plants should be built in the European part of the country, not counting the Ural. However, long-term difficulties are expected with the transport of natural gas. Furthermore, new natural gas deposits would have to be found to secure the long-term supply. The consumption of petroleum in power plants must be reduced. Consequently, increased power production in this area must basically be secured by nuclear power plants. Transmission of electricity from the heat power plants in the Ekibastus and Kansk-Achinsk coal area to the Center is recommended only in case the growth of basic load cannot be covered by nuclear power plants. Transmission of electricity from heat power plants in western Siberia (Surgut) and from hydropower plants in Siberia to the Center, as well as the construction of heat power plants in the Center itself, fueled by Kusnetzk coal, would be uneconomical.

The electrical supply of the Ural area should be secured by transmitting electricity from the Ekibastus heat power plants, by means of 1150 kV AC transmission lines, and by building heat power plants fueled with Kuznetsk coal. According to the expected load diagrams, heat power plants based on Kansk-Achinsk coal, as well as hydropower plants, should be built for the EVS Siberia (to cover average and peak loads).

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ELECTRIC POWER AND POWER EQUIPMENT

PROGRESS OF BELOYARSKAYA AES

Moscow IZVESTIYA in Russian 17 Aug 79 p 2

/Interview with Yu. Petrov, secretary of the Sverdlovsk party obkom by an IZVESTIYA correspondent; date and place of interview not given: "Hot Time at the Construction Site"/

> /Text/ The construction of a new power unit at the Beloyarsk atomic power station has entered the decisive stage. The heart of the atomic giant is the fast neutron reactor. At present work has begun on starting and tuning up the reactor. The newness and complexity of the system of reactor control causes many difficulties. It will still take the many efforts of builders, installers and power engineers for the atomic unit to be put into operation. An IZVESTIYA correspondent has met with Yu. Petrov, secretary of the Sverdlovsk party obkom.

Our newspaper has already reported that in building the new breeder reactor "BN-600" much attention was given to socialist competition, a new form of relations between power engineers and installers with the suppliers of equipment--the "work relay". What are the concrete results of the "work relay"? In what is the value of its experience?

This experience is valuable, above all, because the "work relay" has become accelerator for the creation of the "BN-600" reactor as it helped to establish mutual aid and interaction between all the scientific and production collectives which have designed it and are building it.

It is known that our energy builders were among the initiators of competition according to the principle of "work relay" between planning institutes, equipment-supplying enterprises, construction organizations and operation specialists. The party organization of the oblast pays great attention to the "work relay". We applied to the collectives of supplying enterprises, met with their representatives and concluded agreements defining mutual obligations. This helped to speed up considerably the delivery of equipment to the construction site.

Seeing the vitality of this form of socialist competition, we decided to apply it widely also within the construction, by developing, so to speak, a "small relay" between the collectives of builders and installers.

All this work is led by the oblast headquarters for construction of the third unit of the Beloyarsk AES built last summer. It is composed of party, Soviet and Komsomol workers of the oblast and rayon, economic leaders, and party committee secretaries of organizations participating in the construction of the power unit. Headquarters carries the day-by-day control of construction and once a month discusses in detail all the problems on the spot with the economic and party leaders of all collectives participating in the construction. As to concrete results of the "work relay", in the present stage the foremost of them is that it has sharply speeded up the delivery of equipment to the construction site."

/Question/ And how are things at the construction site itself?

/Answer/ Today's situation at the construction site is tense. This, paradoxically, is a consequence of the great effect of the "work relay". About a month ago there were serious delays in a number of deliveries to construction. The "work relay" allowed putting into action reserves that solved the problem. And there, as a powerful flow of equipment began to reach the site, the builders turned out to be unprepared for such a pace.

Judging by the figures, the situation may seem good. The seven-month plan has been fulfilled 113 percent according to the general contract. Since the beginning of the year 15 million rubles have been used for construction and installation work. The important technological operation completing the accumulation of sodium needed to fill the reactor was finished; this allowed beginning complex special work on the start and adjustment.

At the same time, however, the builders, installers and operation specialists, not without help from planning organizations, tolerated a big lag in the fulfillment of project tasks. The trust "Uralenergostroy" (manager A. Doronin), the construction administration of the Beloyarskaya atomic power station (chief P. Romanov), the trust "Tsentroenergomontazh" (manager P. Trianfilidi), the trust "Elektrouralmontazh" (manager G. Faynyud), the management of the Beloyarskaya AES (director V. Malyshev) failed to ensure that 156 technological sites were put into operational service. Because of the shortage of builders and installers and because of weak help on the part of the exploitation services, completion goals were wrecked in the construction of steam generators, turbo-generators and station pipelines. Considerable falling behind in obligatory schedules were allowed in the construction of auxiliary facilities: a water-side pump station and a diesel generator station in the near-station assembly; this poses complex problems for all construction participatns in securing the start of the "BN-600" unit at the fixed time.

There are also problems which are difficult to solve on the spot. For example, three-shift work has not been organized on the construction site, and not even two-shift work on some projects of organizations such as "Tsentroenegomontazh". The reason: labor shortage. We expect a solution to this problem--in reality, not in words--by the USSR Minenergo.

/Question/ What is the situation today in regard to filling vacancies with experienced personnel in the collectives which erect "BN-600"?

/Answer/ I will put it straight: the situation is difficult. The decision of the board of USSR Minenergo of 9 July about strengthening the builders' and installers' collectives on the third unit of the Beloyarskaya AES still remains unimplemented. This affects, particularly, the work of the sector of the "Tsentroenergomontazh" trust mentioned above. Of the 150 people who should have been sent to the project, only a part arrived. And the sector fulfilled only 75 percent of its seven-month plan, thereby holding up the work of the following sector. There is also a labor shortage among electric installation workers.

We hope that the ministry leaders will take very urgent measures and that the situation will be changed. As to the builders and installers, they are full of determination to render all their strength so that the pledge to start the reactor "BN-600" by Power Engineer's Day, 22 December 1979, will be carried out in time.

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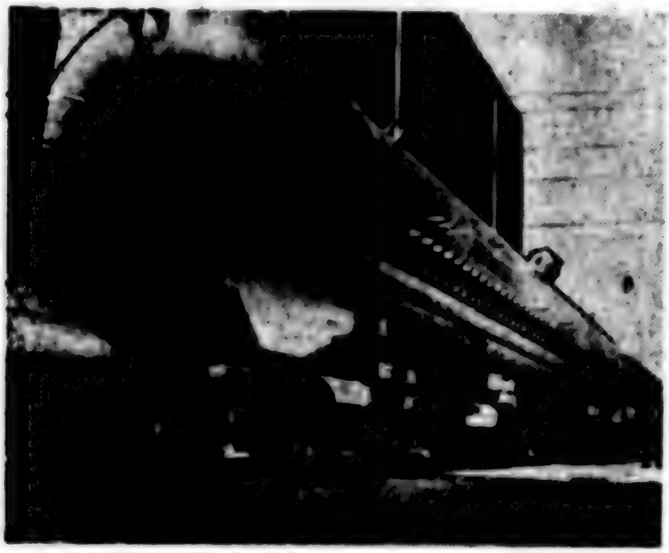
ELECTRIC POWER AND POWER EQUIPMENT

YUGOSLAVIA, USSR COLLABORATION IN POWER ENGINEERING

Yerevan KOMMUNIST in Russian 12 Aug 79 p 4

/Photo by V. Ledkova, Fotokhronika TASS/

/Text/ The economic collaboration of socialist Yugoslavia and the Soviet Union is developing successfully. At the thermoapparatus plant of the Sarayevo association "Energoinvest" the first steam separator for an atomic power station has been constructed for a USSR order.



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ELECTRIC POWER AND POWER EQUIPMENT

START-UP OF ARMENIAN AES NEARS

Yerevan KOMMUNIST in Russian 12 Aug 79 p 1

/Article by Am Meliksetyan, director, Construction Administration of the Armenian AES: "Every Hour Is Valuable"./

/Text/ The time has come for the builders of the Armenian atomic power station, which, in the collective, they proudly call the big assembly. Preliminary work is in progress for the commissioning of the second unit of the atomic power station.

As of today much has been done already, but deadlines are pressing, they seize some people literally by their throats. It is a difficult time, but a joyful one, highly elevated above everyday concerns. The more so, as our creation--the first unit which has already produced over four billion kilowatt-hours of electric energy--is working hard by our side.

On the festive occasion of the Builder's Day we can report: the structural preparedness for the assembly of unit 2 is fully ensured. All subcontract divisions have also been drawn into the competition. Work is especially well done by electricians of the Transcaucasion administration of "Gidroelektromontaszh" (adminstration head, P. Makaryan). And the collective of the Northwestern instllation adminstration (section head, V. Yefimov) is not behind, according to the indicators. In the vanguard ranks march a section of the Stavropol' installation adminstration "Kavkazenergomontazh" and a subdivision of that trust, the Gardaban installation sector.

The results of the work of the past 7 months are characterized by high figures of plan implementation. Individual structures and objects are delivered according to the established schedule, assembling and adjusting of the equipment is performed on time. The indicators are fine, but it is still too early to relax. The delivery of the second unit, planned for December, will be a critical test for the whole collective. Ensuring the start of operation is a difficult and serioues task. More than two thousand people are now working on the erection of the Armenian AES, and they are connected with the whole country. Dozens of supplying plants and supporting organizations decide together with us the fate of the station's startup.

Cargoes now proceeding to the address of the Armenian AES are awaited at the construction site with particular impatience. That is because each day of delay upsets the plan and is fraught with consequences. And where there is haste, lowering of quality is inevitable, which we should not tolerate.

Many supplying organizations postpone and undermine the terms of equipment deliveries; as deadlines are shifted, it is very difficult for us to correct changes in the schedule. The inner housing assembly and the upper block should have arrived from the Izhorsk plant of the Leningrad oblast in July, but according to reports they have not yet passed the inspection assembly at the plant. The time of delivery of removable parts of the main circulation pumps by the Izhorsk people has not been fixed either.

Apprehension is also aroused by the shift of the delivery time of the high-pressure preheaters by the Taganrog Departure Yard "Krasnyy Kotel' shchik". There is no information so far on the arrival of high-pressure fittings from the Chekhov "Energomash". Indebted to the collective is the Bagleyskiy plant of the USSR Ministry of Power and Electrification which supplies pipelines and metal structures to serve the engine section.

Serious concern is caused by the shortage of highly skilled installation personnel, especially high-class arc welders in some of our organizations, in particiular in the Octemberyan assembly section of the Central Construction Bureau of Large Power Machinery and "Gidrosantekhmontazh". Their departmental management in Baku and Stavropol ought to take practical measures in order to ensure the synchronous conducting of work according to schedule and on a level of high quality.

The timely start of the second unit of the AES is not only a matter of honor for the Armenian builders and the multinational collective helping us, it is also a matter of great importance for our republic which does not have reserves of solid or liquid fuel. The hydropower potential of the republic has also sharply decreased because of the concern about Lake Sevan. The senergy from the Armenian AES will allow the saving of thousands of tanks of liquid fuel, it will free transportation; natural gas will be allotted to the needs of chemistry for production of more expensive products for the industry and economy. The AES collective is perfectly conscious of all these circumstances. Therefore the socialist competition for the previlege of being on the honorary last shift on the starting day of the new unit is spreading more and more widely.

Considerable support is given to the construction in Metsamor by the USSR Ministry of power, Central Committee of the Communist Party of Armenia and the Council of Ministers of the republic. They treat our requests and needs with attention and concern and speedily resolve the most important problems.

Every day brings us closer to the crucial finale. And every day is decisive for the fate of the operation start. We, the builders, are already used to the fact that the holiday at Autumn's threshold, Builder's Day, always reminds us: the year's borderline is near, which means that the finish of one more construction project is approaching. This time it is a very important construction project the second installment of an atomic power station whose energy is awaited by new houses, enterprises and other important facilities.

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ELECTRIC POWER AND POWER EQUIPMENT

PRINCIPLE OF WATER-STORAGE ELECTRIC STATION EXPLAINED

Kiev PRAVDA UKRAINY in Russian 4 Aug 79 p 4

/Article by A.A. Milyutin: 'What is a Gaes?'/

/Text/ The word GAES is sometimes seen in the newspapers. What does it mean?

A. Zadorozhniy, Shostka

The reader's question is answered by A.A. Milyutin, director of the Middle-Dnieper series of hydroelectric stations, Hero of Socialist Labor:

On the daily diagram of electric energy consumption you can see considerable gradients: first comes the morning peak, later a small respite toward the evening, and then again a "splash". As we switch on lights, TV sets, electric appliances in our apartments, the energy expenditure increases sharply. And only about midnight a decrease begins and it continues until morning.

Such jumps considerabley complicate the work of thermal-power stations which are designed for steady performance. At the small-load hours they are forced to lower their power; during the sudden change to the peak period this leads to considerable fuel overexpenditure. With the water storage power station /GAES/ it is a different matter. They instantly keep pace with all load changes. At night, when the energy consumption is small, the units of a GAES force water into an upper lake. And during the peak hours water gushes back through giant pipes onto turbines producing current. The station will then work like the usual hydroelectric power station.

The country's first GAES was constructed at our Vyshgorodok on the shore of the Kiev sea. Every year it supplies 100 million kilowatt-hours of additional electric energy to the capital of the Ukraine and near-by cities.

In the near future GAES's are to appear near Moscow, Leningrad, Kaunas and Minsk. Suitable platforms with level differences between a lower and an upper basin have been chosen for some ten more stations. But it is known that in the European part of the country flat relief is perdominant. For this reason a project has been worked out for a basically new, subterrenean GAES.

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ELECTRIC POWER AND POWER EQUIPMENT

NUREKSKAYA GES PUT INTO OPERATION AHEAD OF SCHEDULE

Moscow IZVESTIYA in Russian 28 Jul 79 p 1

/Article by "Izvestiya" correspondent B. Surkov: "The Nurek Acceleration"/

/Text/ Nurek is getting ready to put a hydroelectic station, the largest in Central Asia into operation at full capacity and ahead of schedule. This event is to take place a year earlier than scheduled.

Today the last of the 54 million cubic meters of rocky ground are laid into the body of the dam which is the tallest in the world. This dike, 300 meters high, rose toward the skies in the Pulisangin gorge, stopping and then changing the primordial course of the Vakhsh. For the first time a dike was made of rock; it is safer this way in a zone of ten-point seismic activity. In damming the Vakhash, the dike created an artificial sea expanding over one hundred square kilometers.

What is still left to do is to store "only" a billion and a half cubic meters more to reach the projected volume. Then the powerful water pressure will make the hydroelectric station run at full power.

The work is carried on ahead of calendar dates and obligations by the now famed masters of the Nurek section of the "Spetsgidromontazh" trust, initators of an all-union competition according to the principle of "work relay". They conduct the installation of the ninth, the last unit with a guarantee of excellent quality. It is the first one to be assembled and operated completely water cooled. This is the prototype of electric machines for the future Rogunskaya GES on the Vakhsh, the most economical and perfect of machines.

But what is the Nurek GES? It is one of eight stages of the Vakhsh series, its fourth station. The series will produce 36 billion kilowatt-hours of cheap energy annually for all republics of Central Asia and other regions of the country. The series will allow the solving of the problem of total and, in the first place, seasonal utilization of water reservoirs for power and irrigation. This means both the creation of new industrial centers and the opening up of new cotton-growing areas in Tadzhikistan, Turkmenia and Uzbekistan. It means, finally, a guarantee of stable harvests in all Central Asian regions requiring irrigation and belonging to the Amu Darya basin.

A paramount role in the work of the whole future series of electric stations is assigned to the Nurek GES. As of today it has already given 20 billion kilowatt-hours of electric energy to the national economy of the republics of Central Asia.

Nurek lives tensely now. Time is counted by days and hours. Says A. Malinov, first secretary of the Nurek party gorkom:

"An obligation was assumed to put the station into operation by 7 November. Now it has been revised. We will start the GES by 7 October, the USSR Constitution Day. One year and three months will be saved."

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ELECTRIC POWER AND POWER EQUIPMENT

ELECTRIFICATION OF GOR'KOVSKAYA OBLAST

Moscow PRAVDA in Russian 24 Jun 79 p 2

/Article by PRAVDA correspondent G. Ivanov: "With the Correspondent's Commentary: Who Is More Important?"/

/Text/ Our zonal electrical network enterprise serves the North of Gor'kovskaya oblast--six administrative rayons. This is a vast territory, a forested region with many of the transmission lines passing through marshes off the roads. Damage occurs often in them, especially during strong wind, frost and thunderstorms. And then you have to come out there speedily to remove defects quickly.

But it turns out that it is not always "quickly," far from it. Serious obstacles arise because of lack of the transportation and communications. The enterprise has few motor vehicles. Besides, many of them are of obsolete makes. Two-thirds were received 15-20 years ago. And only one or two new ones are allotted every year. There is little hope of overhaul; this requires spare parts. But the associations of Raysel'-khoztekhnika /regional union for agricultural equipment marketing/, where we are "on allowance", carry out our orders reluctantly, at the bottom of the list.

The condition of the fleet of motor vehicles is extremely alarming. Dirvers do not wish to work with them, they change frequently, which complicates the situation even more. You start out on such a vehicle to remove a breakdown and you are not sure that you will reach your destination.

Fine, if the damage can be repaired in a short time, but it may trun out so serious that a special repair crew has to be called and materials supplied. And to the

nearest telephone there are many miles of bad roads. In such cases the proper thing to do is to communicate by radio. But then there are not enough portable radio sets either, or they are worn out, decrepit, require repair, and spare parts are not available.

And so it happens that removing the damage sometimes takes half a day or even more instead of two-three hours. For this we are justly blamed. We understand that our service ought to be reliable and operate rapidly and efficiently so that there is no interruption in the work of farmers and cattlebreeders. Why, then, are the needs of rural electricians attended to so poorly?"

(From a letter by Yu. Zverev, N. Zhuravlev, S. Mutovkin and other electricians of the Urenskiy Electric Network Enterprise of "Gorenergo". Altogether 30 signatures.)

An argument was started in a theater: Who is more important--the electrician, producer or theater carpenter? It was not difficult for the electrician to demonstrate visually how important his role was--he just switched off the lights in the whole theater, and sure enough, the performance was called off.

This is a humorous tale and the method described in it is not to be imitated. The Uren' electricians do not act like this, of course. On the contrary, they are trying to do everything possible so that consumers get their electric energy continuously. In particular, a complete overhaul of electric lines and substantions has been extensively introduced at the enterprise. And that is producing results.

The authors of the letter justly write about the importance of their labor. A vast and complex economy is entrusted to rural electricians. At the Uren' Enterprise 100-150 kilometers of transmission lines are allotted to each of them. The load is not lower in other subdivisions of "Gorenergo", and in some places it is even higher.

These are large-scale figures, it goes without saying. But when the talk turns to material and technical supplies, much more modest figures are quoted. There is no need to prove that reliable transportation is a primary concern in electricians' work. However, here is information which was given by "Gorenergo": In the last 3 years management has received only 103 motor vehicles to be distributed among 22 enterprises. Moreover a considerable part of this replenishment consisted of special machines which you could not call means of transportation. As a result the motor pool is renewed much more slowly than it is growing old; it is wearing out and dropping out of operation.

But this is not the only point. For a long time the wish has been expressed to provide rural electricians with transportation that would meet the specific requirements of their work. Some years ago at one of the "Gorenergo" enterprises they decided to create something of this sort. They put a second cabin on the motor car. The whole crew was accomodated in it. The car was summoned to Moscow by the Ministry of Power and Electrification. The specialists like it. They commended the Gorkiy people for their initiative and promised to see to it that henceforth the reequipping would be conducted not by handicraft, but in plants. And, incidentally, an opportunity as given to equip the cars with everything needed by electricians--tools and instruments. And, at last, with those radio sets. The intentions were good, but they never were followed by practical steps. There is much talk about equipping rural electricians, especially with special winter clothing, sheepskin coats, fur mittens etc. But so far to no purpose either. They don't even have tool bags.

Now what are the reasons? As the authors of the letter report, more than once they presented their needs both to the Borkiy administration and to the Glavtsentrenergo /Main Administration for Exploitation of Power Systems of the Central Region/. Of course, also at the Ministry of Power and Electrification they know about it. To all requests there is one reply: There are no funds, manage with what you have. At the same time it is urgently suggested that contacts with customers be strengthened. But there are contacts and contacts. When last winter during hard frost in the Lukoyanov rayon 8 kilometers of electric lines went out of order at once, local organizations there and then sent people and allotted technical equipment. Joining forces, they succeeded in removing the damage. Who will object against such contacts? But here is a different situation. It is necessary to go out to the line, but the cars are in disrepair. So they have to ask the customer to please provide a vehicle, if only a tractor. The customer does not refuse, of course, he is, you see, above all interested in an uninterrupted supply of electric power. These are also contacts of a sort. But, can they be counted on? You cannot call them anything else but parasitism.

The power supply is said to be the pivot of production. Its base in rural regions is being continually expanded. In the Gor'kovskaya oblast new transmission lines are now being laid, transformer stations erected, etc. How is reliability of their operation to be secured? For instance, the idea of creating a special service has been expressed, which would take the exploitation of the whole energy base of the countryside in one hand. In any case the present operation level of lectric network enterprises is already insufficient. The ministry and the planning organs should change their attitude toward that service and see to it that its material and technological needs be provided for. It is one of the principal services of the present-day countryside. And there is no question as to who is more important, the electrician or the machine operator. Both of them are doing the same job.

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ELECTRIC POWER AND POWER EQUIPMENT

CRYOGENICS APPLIED TO POWER ENGINEERING

Moscow IZVESTIYA in Russian 28 July 79 p 2

/Article by V. Belyakov, director of the scientific production association "Kriogenmash", corresponding member of the USSR Academy of Sciences: "Deep-Cold Professions"/

/Text/ A new trend in science and technology has taken shape in our time, connected with the study and utilization of cryogenic systems. Translated from Greek, "cryogenic" means "cold-producing". This term serves to denote processes and devices which allow one to obtain superlow temperatures in the range from -153°C down to absolute zero.

For a long time the only industrial application of cryogenic technique was the separation of air, compressed beforehand, into its components. The point is that oxygen, nitrogen, argon and other components of atmospheric air are highly valuable technical gases.

Soviet science enjoys priority in the development of many technological processes using oxygen and nitrogen in metallurgical and chemical processes. Nowadays practically the whole volume of pig iron produced is smelted with the application of oxygen. Its use in furnace blasting allows increasing the furnace productivity; at the same time the specific consumption of coke is lowered.

In recent years the development of metallurgy was accompanied by the increasing use of pure oxygen for the needs of the L-D process in steel founding. The basic advantage of this method is higher speed of smelting. Introduction of cryogenic equipment into metallurgy results in very substantial saving: one million rubles of capital investment for creation and introduction of air-seperating installations alone saves about 8 million rubles annually.

Soviet cryogenic engineering has created reliable and highly economical air separation installations of high productivity have become basic for metallurgical production. They allowed the solving of important national-economic problems regarding increased output of pig iron by both currently operating and new blast furnaces and open-hearth furnaces.

Last year the Krivoy Rog metallurgical plant was furnished with an air-seperation installation with a capacity of 70,000 cubic meters of "blast furnace" oxygen per hour for a gigantic blast furnace of 5,000 cubic meters of usable volume. The creation of such a powerful installation, which does not have its match abroad, presented a complex scientific and technical problem. Foundations have now been laid for even more powerful installation which in the future may be needed for conversion of mineral coal into fuel for the huge MHD electric power stations. In the last two decades the demands for cryogenic equipment have been sharply increasing. High energy physics, power engineering, instrument making, medicine, argiculture demanded the development of industrial-scale technology for obtaining cryogenic cold down to the temperature of helium liquefaction, -269°C. The attention of scientists and power engineers of the whole world is now turned to the search for the long-term replacement of conventional fuels--oil, natural gas and coal. Hydrogen, whose reserves in nature are practically inexhaustible, is considered to be one of the substitutes. Hydrogen is a high-calorie fuel, "clean" in the ecological sense since water is its combustion product. It will be used in metallurgy for direct reduction of iron, in automotive transport and many other fields of technology.

The mass use of liquid cryogenic products required the creation of a wide variety of cryogenic equipment for production, storage, transportation and gasification of cryoproducts. This problem was successfully solved by domestic cryogenic engineering.

One of the remarkable discoveries of our age is superconductivity. It appears only at temperatures of the order -260°C to -270°C. Superconductivity opens up great possibilities for further development of power engineering and electrical engineering. Technical utilization of this phenomenon allows, in principle the, replacement of aerial electric transmission lines by superconducting cables in which losses of electrical current are absent and the energy dissipation is reduced to the maintenance of the required temperature only.

An important problem of present-day physics and power engineering is the creation of strong magnetic fields indispensable for direct conversion of heat energy into electric energy in MHD generators, for thermonuclear reactors and for acceleration of elementary particles to superhigh energies. Obtaining magnetic fields by the usual method requires a large expenditure of electric power and is connected with the necessity of erecting unwieldy structures whose weight runs into thousands of tons and whose dimensions exceed present engineering possibilities. It is a different matter with superconducting magnetic systems in which the magnet windings are cooled by means of liquid or cooled gaseous helium. Such superconducting solenoids produce superstrong stationary magnetic fields of high intensity.

Intensive work is in progress on models of cryogenic superconducting electrical machines: electromotors and generators with superconducting windings. The unit power of such electric machines will be considerably higher than that of the existing machines.

Much attention is nowadays given by specialists to the creation of reliable, small-size cryogenic machines and devices of relatively low capacity which work in combination with radio and electronic devices. Deep cooling of the active parts of infrared radiation receivers as well as quantum generators and amplifiers ensures highly efficient operation. This field has developed into a special branch named microcryogenic engineering.

Cryogenic cold is increasingly applied in biology, medicine and in the food industry. Thus, liquid nitrogen is used for prolonged conservation of blood, marrow, sperm and other biological substances. Systems of freezing, conservation and transportation of perishable products in a nitrogen medium have been developed. In medicine a cryosurgical instrument is successfully used: it makes possible local removal of diseased organs and tissues.

The Basic Directives for Development of the USSR National Economy in 1976-1980, adopted by the 25th party congress, envisage creation and introduction of powerful oxygen installations for ferrous metallurgy, further expansion of the L-D method of stell smelting, development of research in plasma physics, work on creation of superconducting electromechanical systems, etc. The development and mastering of new efficient cryogenic equipment is an indispensable condition for solution of the important tasks faced at present by many branches of national economy.

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ELECTRIC POWER AND POWER EQUIPMENT

BRIEFS

TURBINE ROTOR FOR GES--Leningrad, 21 Aug--The rotor for the turbine of the Sayano-Shushenskaya GES has been shipped from the association "Leningrad Metal Plant". The powerful floating crane "Vityaz'" lifted the 140-ton bulk from a moorage berth and transferred it onto a big-load pontoon. Last night it moved under the Neva drawbridges into the maritime port. Here the wheel will be loaded on the specially equipped motor vessel "Spvetslaua Yakutiya" and delivered via the northern maritime water-way during the present-year's navigation to the construction site as was stipulated by the agreement on creative collaboration between collectives participating in the erection of the GES on the Yenissey. /Text/ /Moscow PRAVDA in Russian 22 Aug 79 p 1/ 12157

RECORD WELL--Petropavlovsk-Kamchatskiy; O. Dzyuba--The hydrologists did not expect anything sensational from this well. They drilled it to supply hot water to the settlement. As the drill reached 225 meters, surprise was followed by surprise: the rate of steam flow was 10 kilograms per second, temperature 230°. There are few wells with such indicators in the whole world. Here the drillers will have to go as deep as 1500 meters. A powerful geothermal hydrostation on the Mutnovskoye field is planned. /Text/ /Moscow STROITEL'NAYA GAZETA in Russian 8 Aug 79 p 3/ 12157

ENERGY OF THE KAMA--Naberezhnyye Chelny (Tatar ASSR)--The first unit of the Nizhnekamskaya GES has been put into operation. Today it began to supply current. The builders assembled the unit in 4 months. The work speed-up was furthered by the adoption of a progressive method of assembling larger units and by specialization teams for certain units. Preparations have started for the installation of a second water turbine which the builders have pledged to introduce this year. The Nizhnekamskaya GES, with more than 1,200 kilowatts power, will be the third and biggest on the Volga tributary. It will allow considerable improvement in the power supply of the Kama Motor Vehicle Plant oil fields, and petrochemical and other enterprises of the Kama region. The GES will also become an important road junction: a bridge will be built over its dike onto which a motor road and a railroad will be layed. They will connect the KamAZ with the Urals and Siberia. /Text/ /Kishinev SOVETSKAYA MOLDAVIYA in Russian 8 Jul 79 p 1/ 12157

TAYGA ELECTRIC LINE--Komsomol'sk-na-Amure; TASS--Construction of the LEP-220 /electric transmission line/ has begun: it will run from Komsomol'sk on the Amur via the Berezovyy settlement to Urgal. Ten fast-growing settlements will receive a reliable power supply from the new central heat-and-power plant. /Text/ /Moscow IZVESTIYA in Russian 15 Aug 79 p 1/ 12157

ROCK TUNNEL TO DAM--Sayanogorsk; TASS--The cutting of a 260-meter transport tunnel to the upper marks of the dam of the Sayano-Shushenskaya GES has been completed a month and a half ahead of time. The new route for cement trucks, breached through the rocks on the right bank of the Yenissey, will considerably speed up the erection of the high-altitude dam and will help to make up for the time lost during the terrible flood. Its after-effects have now been liquidated almost completely and the construction is running at the pre-start pace. Two more units are planned to be put into operation this year. /Text/ /Moscow IZVESTIYA in Russian 15 Aug 79 p 1/ 12157

GENERATOR FOR KAZAKHSTAN--Karkov; A. Zoshchenko--The collective of the Kharkov plant "Elektro-yazhmash" has completed an important task. A turbo-generator of 500,000 kilowatts has been shipped to the power engineers of the Ekibastuzskaya GRES-1. The workers of the enterprise have pledged to manufacture ahead of time, until the end of the year, one more unit for the Kazakhstan starting project. /Text/ /Moscow IZVESTIYA 26 Aug 79 p 1/ 12157

LAST UNIT INSTALLED--Dushanbe; TASS--The rotor of the last, the ninth in the series, turbine of the Nurek GES has been delivered at the construction site. Assembly of the stator and rotor of the power machinery is already completed. It was decided to install the turbine rotor in a shorter time. This part of the unit was manufactured by the association "Kharkov Turbine Plant". Armed with the experience accumulated in constructing eight preceding hydrounits, the builders revised the deadlines and decided to deliver the ninth unit on 7 October, a month earlier than projected in the socialist pledges. /Text/ /Moscow EKONOMICHESKAYA GAZETA in Russian No 36/Sep 79 p 3/ 12157

NEW POWER STATIONS--The present half-year is a remarkable one for the builders of the USSR Minenergo in that they have to conquer an unusual frontier by putting into operation turbo-units of 11.7 million kilowatts total power. This is almost three times as much as was commissioned during the corresponding period of last year. The installed capacity of the atomic power plants of the country has already reached 10 million kilowatts. Specialists are particularly interested in the work of the builders and installers of the Beloyaeskaya atomic power station, who for the first time in this country are preparing the start of a 600-thousand-kilowatt breeder reactor. Crucial tasks are to be carried out also on facilities of conventional thermal power engineering. Widescale work is now being developed on the first super-powerful TETs of the Kansko-Achinskiy and Ektabuzskiy heat and power complex. /Text/ /Moscow STROITEL'NAYA GAZETA in Russian 12 Aug 79 p 1/ 12157

CHECKING HEAT LEAKS--RATAU correspondent V. Chamara--How reliable is the heat insulation of a TETs? Where are the "gaps" in it and how large is the leakage of thermal energy? A device created by the scientists of the Institute of Thermophysics of the USSR Academy of Sciences will help to obtain answers to these questions. A round lamella of the size of a five-kopeck coin like a doctor's stethoscope will listen to the "breathing" of the insulation and instantly transmit all data to a measuring device which will communicate the desired information. "The principal part of the heat meter is a sensor," says the director of the work O.A. Gerashchenko, corresponding member of the UkrSSR Academy of Sciences. "It consists of 2000 very thin, hair-like thermoelements which ensure extraordinary sensitivity. When such a microbattery comes in contact with a surface and a heat flow passes through it, a temperature difference arises on the edges of the sensor, generating an electric signal." The big power stations of Kiev, the Donbass, Dnepropetrovsk, Vinnitsa are equipped with the new devices, as are most of the sugar mills of the republic. /Text/ /Kiev PRAVDA UKRAINY in Russian 14 Aug 79 p 2/ 12157

FIRST LITHUANIAN ATOMIC STATION--Lithuania's first atomic power plant is under construction. The building site is a region in northeastern Lithuania near the borders of Latvia and Belorussia. These republics are to receive part of the electric power generated in the future. The Lithuanian atomic power plant will receive a graphite channel reactor with a capacity of 1,500 mw. This is the largest reactor of this type of those previously manufactured in the Soviet Union. [Bonn DIE WIRTSCHAFT DES OSTBLOCKS in German 14 Sep 79 p 9]

SIBERIAN HIGH-VOLTAGE LINE--A 272-kilometer, 1,150 kv high voltage power line is being constructed in Siberia. The line will be laid near Itat, Kemerovo and Novokuznetsk, and in the future will be extended to the Urals and Kazakhstan. During the construction large towers with compression-shaped cables will be used. These have already been used in a super power line tested in the Moscow area at this unit stress. The Moscow test line has a length of 1.5 km. [Text] [Bonn DIE WIRTSCHAFT DES OSTBLOCKS in German 14 Sep 79 p 7]

CSO: 1826

GASOLINE-WATER EMULSION FUEL

Moscow SOVETSKAYA ROSSIYA in Russian 19 Aug 79 p 3

[Article by Yu. Andreotti: "Water Does Not Interfere With Gasoline"]

[Text] "Dear Editors! Much is heard about the worldwide energy crisis. Is anything being done to find means of economizing on gasoline or its substitutes for motor vehicles? Tell about this in your newspaper. [Signed] V. Trofimov, Petrozavodsk."

Tens of the same passenger busses arrive every day at one of the refueling stations in the Moscow suburban town of Khimki. A liquid of an unusually white color instead of clear gasoline is poured into the tanks.

"It is a gasoline-water emulsion," explains the driver to the drivers of the other vehicles.

This scene had to be observed before a meeting with V. S. Savodov, head of the Fuel Economy and Environmental Protection Laboratory of the Scientific Research Institute of Motor Vehicle Transport (NIIAT).

"Our laboratory was created especially on the basis of motor vehicle column 1786," relates V. S. Zavodov. "Here we are introducing many of our own developments into practice. The country's first experimental operation of busses on a gasoline-water mixture was begun. In this case the engines do not have to be fundamentally remodified. We only improved the supply system somewhat."

How is the new type of fuel "operating?" After all water and gasoline were always regarded as substances with opposite properties. Morover, they do not mix.

Experiments on the gasoline-water mixture were conducted in our country even before the war. The mechanism of combustion of similar fuel in which water is transformed from a harmful impurity to a noble component has recently been determined. One essential condition is required for this--the water and gasoline must be broken down into the finest droplets microns in diameter

and must be mixed uniformly. This mixture is also interesting due to the fact that low-grade gasoline becomes high-octane, it burns completely with fewer deposits, reduces the carbon monoxide level in the exhaust by more than a factor of two and the discharge of nitrous oxides is reduced by half. And this is essentially with operation of a large number of motor vehicles in large cities.

Laboratory experiments with water-gasoline mixture on individual automobiles were also conducted earlier by different organizations. Small amounts of the mixture were prepared locally. An industrial installation was required for an extensive experiment. Workers of NIIAT developed it and installed it in motor vehicle column 1786. It is already producing approximately 3 tons of fuel mixture per hour and can meet the needs of a fleet of 300-400 busses. The scientists have been able to prevent the mixture from separating for a month by adding a stabilizer and it is clear to even the beginning driver what a threat water is if it enters the fuel delivery system in pure form. Therefore, the search of investigators to develop more stable mixtures is continuing.

"In any case," V. S. Zavodov says in conclusion, "a gasoline-water mixture has already proved the promise of extensive introduction. Up to 70 percent water is used in it. After completion of the experiment, the gasoline-water mixture will be recommended primarily for refueling motor transport in the cities."

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CSO: 1822

HYDROGEN: FUEL OF THE FUTURE

Kiev RABOCHAYA GAZETA in Russian 5 Sep 79 p 3

[Article: "Hydrogen--Fuel of the Future"]

[Text] The idea of using hydrogen as the fuel of the future is becoming ever more realistic. This most widely distributed chemical element in the universe has been recognized as the most promising energy carrier. The experience accumulated by Soviet scientists in the field of production, transport and storage and use in the national economy was generalized at the guest session of the Committee of the USSR Academy of Sciences on Hydrogen Power Engineering, held on 4 September at Zhdanov.

"Our committee," it chairman Academician M. A. Styrikovich said to a RATAU correspondent, "is now coordinating the work of more than 100 scientific research and planning organizations of the country which are working out different aspects for development of hydrogen power engineering and technology. We are talking about producing hydrogen from water by using nuclear energy or inexpensive coal and further use of it in various sectors of the national economy."

Besides problems common for the entire country, regional problems and specifically those concerning the Donbass were considered at the meeting.

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CSO: 1822

OFFSHORE DRILLING OPERATIONS NEAR SAKHALIN ISLAND

Moscow IZVESTIYA in Russian 18 Sep 79 p 1

[Article by A. Pushkar', special IZVESTIYA correspondent: "Offshore Drilling Rigs"]

[Text] "Offshore drilling rig, this is Yuzhno-Sakhalinsk. Please report to what depth you have reached."

"According to tne echo-sounder, 31 meters. It is 500 meters at the bottom."

"And how is the weather?"

"It is okay for flying. We are waiting for you."

Every morning the island talks by radio telephone to those offshore where the floating drilling rigs and engineering and geophysical vessels are operating.

"Organize geological prospecting operations more extensively in the shelf zones of the seas and oceans, primarily for oil and natural gas"--this transparency with the line from the decisions of the 25th CPSU Congress attracts the attention over the entrance to the building of the Pacific Ocean Marine Geological-Geophysical Expedition Soyuzmorgeo. The chief geologist I. Khvedchuk related that a vessel equipped with improved geophysical systems for seismic prospecting and magnetic and geochemical surveys is operating in the expedition. The search begins when the location of the geophysical ship is determined with high accuracy. A three-kilometer hose with a school of "fish" --sensors of various devices, is lowered into the water.

The geophysicists, just like fishermen, work on the open deck day and night from early spring to late autumn. Whereas seismic prospecting is conducted by explosives on land, the marine geophysicists used a more economical pneumatic emitter, less harmful to marine life. The intensity of its pulses is sufficient to obtain the same data as when using explosives. Preliminary data processing is carried out by using computers on board the ship.

This is the engine room. Here are ranks of gray cabinets, storage devices and printers, processors and information storage devices. The operators at the display screens monitor the course of fulfilling the tasks. The gathered material processed here. Profile charts by which the direction of future operations is planned are constructed.

The marine geophysicists process as many profiles per month as can be processed per year on shore. Areas promising for oil and gas are being prepared through their efforts.

They are working hand in hand with specialists of the Far Eastern Marine Deep Drilling Oil and Gas Prospecting Expedition. The first well which they drilled at the planned point produced oil.

It is known that operations are being conducted on the Sakhalin Shelf in accordance with a general Soviet-Japanese agreement. Good business contacts have also been organized here with American and French specialists.

Every morning the island talks with those at sea. One does not always hear the cheerful answer: "The weather is normal." Sometimes a storm rages and waves beat heavily against the metal supports. But, struggling with the wind, a helicopter takes off from shore and transports the drilling crew.

The search for oil is continuing.

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CSO: 1822

FUELS AND RELATED EQUIPMENT

HELICOPTERS AID IN TYUMEN' DEVELOPMENT

Minsk SOVETSKAYA BELORUSSIYA in Russian 7 Sep 79 p 2

[Article by V. Chechenkov: "On Tyumen's Land"]

> [Text] "We can still live for many years on the Tyumen' reserves," General secretary of the CPSU Central Committee and Chairman of the Presdium of the USSR Supreme Soviet Comrade L. I. Brezhnev said at the 18th VLKSM Congress. "And during the next 10 years, the main increase of oil and gas production and the valuable chemical raw material produced from them will be achieved because of Tyumen'. A new, more complex step in development of Western Siberia is beginning, or rather has already begun in this regard. The volumes of all operations must be doubled and tripled there. This requires both new material and technical expenditures and an influx of people."

The entire country is helping in exploitation of the natural resources of Western Siberia. Drillers from Tataria, Kuybyshevskaya Oblast, the Ukraine and Belorussia have entered the struggle for more oil together with the Tyumen'workers. A new enterprise--the Administration for Drilling Operations in Drilling for Oil Wells in Western Siberia--was created in October of last year at the Production Association Belarus'neft'. The collective of the Belorussian UBR is operating by the watch-expeditionary method at fields located near the town of Nizhnevartovsk. Most workers live at Rechitsa, Sverdlovsk and Gomel'. They are delivered to Nizhnevartovsk and return by aircraft and they are delivered to the drilling rigs by helicopter.

The path to the treasures of Tyumen's land is thorny. An air bridge was created to deliver the first drilling rig for operation at Patochnoye Field --powerful helicopters deliver the equipment and materials and the rail cars for housing. The Belorussian oil workers constructed a production service base through their own efforts and prepared for drilling the wells. The derrick installers took a high working tempo from the first days in Western Siberia. They are now concentrating all their efforts on another area--Vatinskoye Field. Operations at the well-known Samotlor have also been entrusted to the collective.

Honorably fulfilling the socialist pledges of the fourth year of the 10th Five-Year Plan, the Belorussian Administration of Drilling Operations, which is headed by S. P. Mazurok, reported on completion of the semiannual production program in well drilling on 15 June. The collective was awarded a second monetary prize during the second quarter of this year from the results of the All-Union socialist competition of enterprises and organizations of the Ministry of the Petroleum Industry. The planned task of 8 months of drilling was fulfilled ahead of schedule. A total of 69,452 meters of rock was drilled through. The derrick installation brigade of D. I. Fedurov and the drilling brigades of foremen R. I. Shtoyko and V. L. Alekhnovich, Ye. O. Dorosh and N. Ye. Matsigud made a weighty contribution to the total result.

A good reference point at the Potochnoye Field is the helicopter pad constructed from timbers laid in several rows. Machines and tractors are brought here to take away the goods delivered by air. People are assembled here for transport to Bol'shaya Zemlya. A road has been laid from here to group No. 10. The conquerors of the interior from Belorussia opened their account at the 10th Potochnoy Field at the end of last year by the first few meters of drilling and the first wells constructed by their hands in Western Siberia. This honor went to the brigade of foremen Ye. O. Dorosh and N. Ye. Matsigud, who are operating by the watch-expedition method.

Despite the fact that they have been working together for less than a year, the people here have fused into a powerful collective. And they have begun at the Svetlogor Administration. Assistant drillers V. Azaronok and V. Luk'yanenko, Ye. Plyshevskiy, fitter M. Madzhara and driller V. Nesterenko have sunk wells in the Poles'ye area. They are now fulfilling their labor watch on Tyumen's land.

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